PHILOSOPHICAL

TRANSACTIONS.

X. *On the Anatomy of the Mole-cricket.* *By* J. KIDD, *M. D. and F. R. S. Reg. Prof. of Medicine in the University of Oxford.*

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THE following observations contain the principal points of a laborious examination of the anatomical structure of the gryllotalpa, or mole-cricket; and if I dare hope that that examination has been conducted with any thing like adequate accuracy, I need not apologize for the length of the details with which the account of it is accompanied, since CUVIER has affirmed of an entire volume written by LYONNET on the anatomy of a single species of caterpillar, that it contains not one word that is useless.

Natural science indeed has now arrived at that point, in which individual detail is requisite for the acquisition not only of a surer basis of classification of species, but also of more correct principles of general physiology. Independently however of these considerations, the insect, which is the subject of the present communication, is so singular in its

structure and habits, and is in some parts of the world so formidable to the agriculturist, as to render its history peculiarly interesting.

It is described under various names; as the earth-crab, from its general appearance; vermis cucurbitarius, from the mischief it does to cucumber-beds. By the French naturalists it is called courtilière.

The best account of the mole-cricket with which I have met is in a well known etymological work by RÖSEL, published at Nuremberg in 1749. This account is accompanied by the best engravings also of the external characters of the animal in its different states: and the value of these engravings is greatly enhanced by the accuracy with which they are coloured.

RÖSEL says that about the month of June or July, rarely later, the gravid female gryllotalpa excavates a cavity, from 4 to 5 inches beneath the surface of the earth, in which she deposits her eggs in one heap, to the number of three hundred or more; and dies within a few weeks afterwards. At the end of about a month the young mole-crickets are produced; and appear, on a hasty survey, to bear a general resemblance to the ant. Between the time of their birth and the commencement of winter, the young animals cast their skin three times; they lie dormant during the winter, deeper in the earth in proportion to the inclemency of the season; and during this period cast their skin for the fourth time. About May they leave their winter quarters, and at this time are furnished with the rudiments of their future wings, four in number; which differ remarkably in size and form and position from those of the perfect insect; in which the inferior

wings are folded in a very curious manner, while in the imperfect insect they are always open.

During the month of June or July they cast their skin for the fifth and last time; after which the wings acquire a permanent character, and the insect becomes capable of propagating its species.

RÖSEL says that he himself never dissected a mole-crcket; but reports, on the authority of others, that its stomach resembles that of the locust, represented in his ninth plate of the series of that tribe of insects. I may here add, from my own observation, that it very closely resembles that of the gryllus viridissimus, and also that of a species of gryllus preserved in the Ashmolean Museum, which answers to the pneumora of LAMARCK: it also somewhat resembles that of a locust, marked 614 in the Hunterian collection; and, still more, that of the Cape grasshopper, engraved in the 84th plate of the first part of Sir E. HOME's Comparative Anatomy.

It appears from RÖSEL's account, that while very young, these insects are gregarious, but not afterwards; that they are usually found in the vicinity of meadows and of fields of corn, particularly of barley; to which they are very detrimental by feeding on the roots, and thus intercepting the due nourishment of the plants themselves. I have no doubt of the general accuracy of the foregoing remarks of RÖSEL, and have little to add to his account of the natural history of this insect. I have hitherto met with the mole-cricket in one situation only; namely, in some peat-bogs, at the distance of a few miles to the west of Oxford. In the neighbourhood of these peat-bogs the insects are familiarly known by the name

of croakers, from the peculiar sound which they occasionally make; a sound not very unlike, but more shrill and more soft than that of the frog. This sound, even in the case of a single individual, may be heard at the distance of some yards; but when made by numerous individuals at the same time it may be heard, as I have reason to believe, at the distance of some hundred yards, provided the air be in a favourable state. I have usually found the insect within a foot and a half of the surface, and in parts where the peat was neither quite dry, nor very moist; of such a consistence indeed as is most favourable to the mining operations of the animal.

The accounts of different authors differ as to the food of the mole-cricket. Having kept several individuals in glass vessels during some weeks, I observed, that of all kinds of vegetable food they preferred the potatoe, while cucumber they hardly touched; but if raw meat were offered them they attacked it with great greediness, and in preference to every thing else. And, when they had been kept, though even but for a short time without any food, they did not hesitate to attack each other; in which case the victor soon devoured the flesh and softer parts of the vanquished. As I have not unfrequently found them in their native haunts maimed in various parts of the body, I have very little doubt that, although captivity may increase their ferocity, they are not, even in a natural state, free from each other's attacks. If they are carnivorous, they probably feed on worms, and various larvæ, which are abundant in the peat-bogs above-mentioned, for I have repeatedly found the horny and indigestible parts of insects within their stomachs. Similar relics I have found in the stomach of the pneumora and gryllus viridissimus. The

two following facts attest in the tribe of insects to which the mole-cricket belongs a remarkable degree of voracity, and an equally remarkable power of abstaining from food. My friend Dr. MACARTNEY, of Dublin, informs me that he has known a gryllus devour a portion of its own body: on the other hand, my friend Mr. BUCKLAND, of this University, gave me, at the commencement of the present summer, a living gryllotalpa, which had been confined during nine or ten months in a tin case, containing a small quantity of garden mould, without the possibility of having met with any other nourishment than such as that portion of mould might be supposed to contain.

External characters of the perfect gryllotalpa.

In this, as in the case of every other animal with whose habits of life we are acquainted, we see a perfect accommodation in form and structure to the circumstances in which the individual is naturally placed. Destined like the common mole to live beneath the surface of the earth, and to excavate a passage for itself through the soil which it inhabits, the gryllotalpa is furnished like the mole, with limbs particularly calculated for burrowing; with a skin which effectually prevents the adhesion of the moist earth through which it moves; and with exactly that form and structure of body, by which it is enabled to penetrate the opposing medium with the greatest ease. At the same time, in order to prevent the necessity of its excavating a track so wide as to admit of the body being turned round in case of a desire to retreat, it is endued with the power of moving as easily in a retrograde as in a progressive direction; and, apparently to perform the

office of antennæ, which warn the insect of approaching danger in its progressive motions, it has two appendages, which might not improperly be called caudal antennæ, evidently calculated to serve a similar purpose during its retrogade motions; particularly as they are furnished with very large nerves. The indifference with which the insect is disposed to move in either direction is manifested by the following experiment: if you touch it towards the head, it retreats; if towards the other extremity of the body, it advances.

The general colour of the animal is such as indirectly to serve as a protection to it, being nearly of the same hue as the vegetable mould in which it lives; so that it is not very readily distinguished upon being first turned up to view; and its safety seems to be still farther insured by the appearance of death, which, in common with many other insects, it assumes when suddenly disturbed. This stratagem, for so it may be called, appears to be most decidedly practised by the animal while in captivity; and if thrown at random out of the vessel in which it has been confined, however unnatural the posture may be into which it has been thrown, it remains as it were in a state of catalepsy during half a minute or more; the first indication which it gives of recovery from this stupor, invariably consists in a motion of the extremity of the antenna.

The general colour of the insect is a dusky brown, passing either into a reddish brown, or into an ochry yellow; those parts being of the darkest colour which are most exposed to view when the animal is moving in the open air. Every part of the body is to a greater or less degree covered by a kind of down, which seems to be the efficient cause of its capa-

bility of repelling moisture; which capability is so remarkable, that when the insect is plunged under water, it appears as if cased in silver, or some bright metallic covering: this appearance being evidently derived from a stratum of air, interposed between its body and the surrounding liquid. This down not only serves to repel the adhesion of any moist substance to its body, but also facilitates the motion of the animal, by lessening the degree of friction which would otherwise take place; and it is owing to the same circumstance that there is an unusual degree of difficulty in retaining a sure hold of the insect, even when dead; but more especially when alive, and struggling against detention. The degree of force which it commonly exerts on such occasions is very remarkable; and, from the sensation produced, may easily be supposed to be what Rösel says it is, equal to the counterpoise of two or three pounds. The skin or covering of the insect is in some parts nothing more than a thin membrane; in other parts it resembles soft leather; and sometimes equals horn or even shell in its degree of hardness.

The mole-cricket is more distinctly divisible than most other insects into three separate parts, which I will call respectively the head, the thorax, and the abdomen; although I am aware that the anterior part of that which I call the abdomen is usually considered as a part of the thorax. Of the three parts above-mentioned, the head is not above one-twelfth the length of the whole body; the thorax three-twelfths; and the abdomen eight-twelfths.

The head is united to the thorax, as the thorax also is united to the abdomen, by means of a loose membrane, which envelopes the muscles that pass respectively from one to the

other; and it is in consequence of the looseness of these membranes that the animal is enabled either to separate the connected parts to a considerable distance from each other; or to contract them so closely together as to hide the interposed membranes from view; and, from the arched form of the anterior part of the thorax it can draw in its head under that part, much after the manner of a tortoise. The same flexibility of the connecting membranes enables the animal to place either its head or its thorax at a considerable angle with the rest of the body; a movement which is very characteristic of this insect, and gives it an air of intelligence; the attitude being apparently that of watching, or listening.

*The head.** All the upper part and the sides of the head form a hard, thick, horny case, containing the various muscles which move the jaws; and, in order to strengthen this case, two firm bars run transversely across the bottom both of the anterior and posterior margin; which bars are themselves united together by a still stronger bar or beam, which runs longitudinally from the middle of the one to the middle of the other. There is nothing very remarkable in the parts which constitute the mouth, excepting the maxillary and labial palpi. In the maxillary palpi there are five joints or parts; in the labial there are three; and the last of these joints in each of the palpi terminates in a rounded extremity, like a pestle; this extremity, which is of a honey-yellow colour, is perfectly smooth, while every other part of the palpi has a rough and hairy surface. In their natural position the palpi are bent and projected forward, so as to resemble the fore-legs of a horse in the act of cantering.

* Vide Fig. 1 and 2. Plate XV.

The antennæ, which are situated near the articulation of the mandibles, consist of a great number of minute segments; resembling beads of a circular form: the number of these beads, which varies in different instances, is usually from 100 to 110; rarely more or less: but it is worth noticing that in examining the two antennæ of the same individual, I sometimes found the number of beads greater in one than in the other; and as the terminal bead differs in its form from all the rest, the result of the examination is less open to doubt than it would otherwise have been. Each bead is united to the one that precedes and the one that follows it by means of a soft, white, very flexible membrane; in consequence of which, and of the number of the joints, the insect can move and bend the antennæ with great facility in every direction, excepting at the very root: there the motion is confined by a ridge that only admits of its being directed from behind, forwards, or *vice versâ*.

The anterior edge of each bead is fringed with bristly hair; which, surrounding the joint that connects it to the following bead, gives to the whole, when viewed by a magnifying lens, the appearance of a sprig of equisetum. The beads are upon the whole larger, in proportion as they are nearer to the origin of the antennæ: but here and there, and without any regularity in the variation, one of the beads is either much larger or much smaller than those in the vicinity.

Whatever be the primary use of the antennæ and palpi, on which subject entomologists are not agreed, their general importance is allowed by all; and is evinced in the particular instance now before us by the extraordinary attention bestowed upon them by this insect. Those who may be led

to watch its habits, will repeatedly observe the antennæ bent forwards and downwards, by a curious application of the fore-legs towards the mouth: and then by a regulated motion, not unlike that by which the resin is applied to the bow of a violin, they are passed between the maxillæ: in order, as it would appear, either to moisten the organs, or to disengage from their surface, particles of dust or other extraneous substances which may have accidentally adhered to it. With a more rapid motion the insect from time to time dresses, if I may use the expression, its palpi; bending them inwards and brushing the surface of their extreme parts by a frequent application of the maxillæ. A similar care of the antennæ and palpi is observable in the gryllus viridissimus; with the additional circumstance, that that insect very often passes between its maxillæ the curiously padded surfaces of its feet, much in the same manner as a cat licks its paws.

*The eyes.** The gryllotalpa has two compound eyes, as they are called, and two ocelli or stemmata. LATREILLE uses this expression "ocellus medius subobiteratus;" from which it may be inferred that he supposes the ocelli to be three in number; but after the most careful examination I have not been able to discover more than two. The compound eyes are situated immediately behind, but a little exteriorly to the antennæ: the corneæ of these eyes, which are large in proportion to the size of the head, are segments of a sphere; flattened however on the inner side so as to present a vertical plane surface to a similar plane surface in the opposite eye; and it is remarkable that this part of the cornea, and the mere margin of the rest of it, are the only parts

* Vide fig. 1 and 2.

capable of freely transmitting light: all the remaining portion is covered, on the interior surface, by an opaque pulpy membrane, or pigments of a mulberry colour; yet the portion obstructed by this pigment is in itself nearly as transparent as flint-glass: it is studded over on the interior surface with numerous depressions of a circular form, which, being very closely set together, give it a reticulated appearance.

The stemmata are placed between the middle of the compound eyes, so as to be rather further from each other than from the eye of the same side. They are not so large as a very minute pin's head, of a lenticular form, perfectly transparent, but not quite colourless, resembling particles of very pale cairngorum quartz. In two instances I have found only one of the stemmata, without any trace of the other. An anomaly somewhat of the same kind has been observed by the father of my friend Dr. OGLE, of this University, in the case of a man; on one side of whose breast the usual rudiments of a mamma were entirely wanting.

With respect to the small quantity of light admissible through the corneæ of the eyes of the mole-cricket, it is apparently sufficient for the purposes of an animal living almost constantly underground. The spherical form of that part of the corneæ which is itself incapable of transmitting light is probably intended, as was suggested to me by Mr. WHESSEL, to whom I am indebted for the principal drawing which accompanies this paper, as a protection for the vertical transparent portion.

*The thorax.** The form of this part is that of an irregular

* Vide fig. 3 and 4.

cylinder, passing into a cone towards the anterior part: the upper portion and the sides, which are covered with a remarkably smooth down resembling the finest velvet, form a horny case of considerable thickness and strength; which contains, or, more properly speaking, is almost entirely occupied by the very large and powerful muscles which move the fore-legs. It is divided longitudinally into two equal parts by an almost bony septum of a complicated form: this septum upon the whole bears an obvious resemblance, but in an inverted position, to the deep sternum, together with the furcular clavicle of birds, and is destined indeed to a similar use; to give attachment to the powerful muscles which are to move the anterior extremities. It differs however from the corresponding part in birds in two considerable points. It differs, first, in consisting of two laminæ instead of one: these lamina are parallel to, but distinctly separated from each other, so as to give passage to the esophagus, and room for the attachment of muscles which assist in moving the adjacent parts. It differs again from the sternum of birds by having a very hard spine, which resembles a common thorn, attached to the inferior and posterior edge of the furcular bone, and passing rather obliquely downwards and backwards. This process serves for the attachment of numerous muscles which adhere very firmly to it, and are inserted on either side of the commencement of the abdomen; enabling the animal to bend its thorax to an angle with the abdomen, a posture which has already been described as very characteristic of this insect.

From the under part of the thorax and near its posterior extremity arise the two fore-legs; those singular instru-

ments which so peculiarly characterize the mole-cricket. Compared indeed with the other legs, and with the general size of the animal, they are as if the brawny hand and arm of a robust dwarf were set on the body of a delicate infant; and the indications of strength which their structure manifests, fully answer to their extraordinary size: but I shall describe them more particularly hereafter, and proceed now to the description of the abdomen.

*The abdomen.** In its general form and structure this part resembles the corresponding part of the hornet: but it consists of more segments, and is much less bright in colour. There are twelve segments in the abdomen of the gryllotalpa, of which the nearest to the thorax carries the upper pair of wings on its upper part, and the middle pair of legs on its lower part; the next segment carries the under pair of wings on its upper part, and the hind pair of legs on its under part. These two segments which are usually described in entomological systems as belonging to the thorax, are of a horny consistence and very hard on their upper side; while all the rest are merely membranous; they are also covered with much long and rough hair, while all the rest, excepting the last but one, are sparingly covered with short hairs. The last segment but one is furnished on each side of its upper surface with a row of red hairs or bristles, which are curved inwards in a direction towards each other; obviously for the purpose of preventing the folded extremities of the under wings from falling off the back on either side.

The under surfaces of all the segments are of a thicker

* Vide fig. 2.

substance than the upper, and are covered entirely with a coarse down, which probably gives the animal a more firm hold while in the act of burrowing. In the last segment is situated the vent, formed by three oval flaps, two below, and one above. This segment sends out from each side of its upper surface two caudal antennæ, as I have ventured to call them, of a tapering form, which differ essentially in structure from those of the head, inasmuch as they are not jointed in any part of their extent, excepting at their very commencement: they are furnished with short hairs set comparatively closely about every part; among which are interspersed long single hairs. These caudal antennæ are evidently very sensible, and serve probably to give the animal notice of the approach of any annoyance from behind; they are partially hollow throughout great part of their extent, and muscles may be traced into them from the inner and adjoining part of the abdomen.

The legs. The anterior legs passing out from under the hind part of the thorax, advance by the side of the head in a direction parallel to each other, which is their natural position while the animal is at rest. I should deem it a servile adherence to system were I to describe the parts composing these legs by the terms strictly indicative of the order of their succession; for, thus, that part which answers so eminently to the character of a hand, must be called the tibia. I shall beg leave therefore to state principally that the foreleg of this insect consists of three main parts, with a lateral appendage attached to the last of them. The two first of the three parts bear some general resemblance to the claw of the crab; being short and thick, for the purpose of affording

room for powerful muscles, intended to move the last part; which is the immediate instrument employed by the animal in burrowing.

It might I think be asserted, without the fear of contradiction, that throughout the whole range of animated nature, there is not a stronger instance of what may be called intentional structure, than is afforded by that part of the mole-cricket which I am now to describe.*

The natural and constant position of this member is worth noticing; the palm, as it may be called, facing outwards, and the claws ranging not in a horizontal but a vertical line, so that none of them but the lowermost, and not even this necessarily, touches the surface on which the animal is walking. Accordingly the insect does not make much use of its fore-legs in walking; and, if irritated, it advances towards you with these legs elevated, in a menacing attitude as it were; not unlike the corresponding attitude of the insect, called the mantis. The form of the hand is that of a triangle; the base of which is formed by the four claws, while the apex is situated at the joint connecting this with the preceding part; by which form and disposition, two important objects are gained; for the joint is thus capable of a much greater extent of motion than it could have possessed, had the articulating surface been more than a mere point; and at the same time, the greater extent of the base enables it to act with more powerful and more rapid effect than could have been otherwise produced. The four claws, which form this base, constitute the proper burrowing instrument; and their shape and structure are beautifully adapted to the pur-

* Vide fig. 5.

pose: for instead of being covered with down or hair, like all the rest of the limb, they are hard, and have a perfectly polished surface; doubtless in order to prevent as much as possible the adhesion of the earth through which the animal is to make its way; they have each of them sharp but strong points, which proceeding from a broad base are thus rendered more effectual. In each also of the claws one of the edges is sharp, while the other is comparatively blunt; and all the cutting edges, as also the terminating points, are directed downwards. Their outer surfaces are slightly concave both in the longitudinal and transverse direction; so that all together they form a scoop as it were, by which the earth that has been scraped off by the points is moved out of the way. They are also each of them divided longitudinally on their concave side by three or four slight ridges; so that, though highly polished, their surface is not absolutely smooth: and thus being concave and uneven, they are more apt to retain particles of the excavated earth; which, by filling up the indentations of the claws would necessarily impede their due action. To obviate this inconvenience, an exceedingly curious instrument is attached to the upper part of the concave surface of this member: this instrument consists of two claws, closely resembling those already described, having by their side a small brush as it were, which terminates in two spines. These two claws, together with the piece bearing the spines, arise from a single piece, or handle, which is articulated in such a manner, as to move in a plane parallel to that in which the four claws are placed; but in a direction opposite to that in which they are moved: they are also placed in such a manner that their points and cutting

edges are opposed to the points and cutting edges of the true claws; and hence the two parts, thus opposed to each other, act like the blades of a pair of shears. When first I considered this mechanism, and remembered that in the localities where I had found the animal, the earth was frequently traversed by fibrous vegetable roots, which must necessarily retard its progress, I supposed that it used this instrument as a pair of shears to cut through those fibres. It is RÖSEL's opinion, however, that the instrument is intended to clear the true claws of the dirt that may from time to time collect upon and clog them; and unless both opinions be true, RÖSEL's appears the more probable. But I have not yet concluded the account of the curious mechanism of this member: for the brush which has just been described, has only such an extent of motion as enables it to clear the two uppermost claws, or at most, the three uppermost; the two lowermost however may effectually be cleared by a kind of feathered spur, which, arising from the further extremity of the joint answering to the femur, proceeds directly towards the lowest part of the burrowing instrument, and is easily made to sweep over the surface of the two last claws by bending the intermediate joint, the only difference in its mode of action being, that it passes over their inner instead of their outer surface.

The middle pair of legs, which are the smallest of the three pairs, arises from the under part of the first segment of the abdominal division: they pass out from the body at right angles to the abdomen, and usually are seen in that direction whether the animal be in motion or at rest. They consist each of four parts; a very short coxa, a femur and tibia

nearly equal in length to each other, and a tarsus, which consists of two long and an intermediate short joint; the last joint terminated by two curved spines. There are several sharp, hard, straight spines near the angle made by the union of the tibia with the tarsus; some of which being directed downwards, give the insect a firmer hold in walking.

The hind legs bear a general resemblance to the middle legs; but the coxa, femur, and tibia, the femur especially, are much larger and stronger; the relative position of the parts with respect to each other is the same as that of the middle legs; but their general direction, instead of being at right angles to that of the abdomen, is parallel to it. In addition to several sharp spines placed about the joint of the tibia and tarsus, and directed downwards as in the middle legs, there are four or five others placed at the back of the tibia near its lower extremity, and pointing slightly downwards. The structure of the tarsus scarcely differs from that of the middle leg. These hind legs are evidently the great instruments of progressive or retrogressive motion.

The wings. There are two pair of wings: the upper pair arising from each side of the first segment of the abdomen partially cover the lower pair, which arise from each side of the second segment. In several instances I found adhering to the body, in the vicinity of the roots of the wings, a minute parasytic insect of a light scarlet colour; the number of these parasytic insects rarely exceeded eight or ten in the same mole-cricket, but in one instance I counted nearly forty.*

The upper wings in the full-grown mole-cricket are not

* Vide fig. 5 *a*.

above one-fourth the size of the other pair; they are of an oval form and convex externally; and their nervures or wing-bones, as they are called by Dr. LEACH, are remarkably thick and hard.

The under wings when expanded, measure full three inches from the outer extremity of one to the corresponding extremity of the other. They may be compared in form to a bivalve shell, contracted and elongated towards the hinge, at which point is the joint of the wing; from hence, as many as thirty nervures, almost all of which are remarkably delicate, radiate in straight lines to every part of the extremity. A very thin and nearly colourless and transparent membrane forms the medium through which these nervures radiate; and throughout the whole expanse of the wing, these nervures are mutually united by more delicate nervures, which cross at nearly regular intervals, and at right angles from one to the other, presenting altogether the appearance of a curiously checquered surface. These wings, though so broad when expanded, are scarcely the twelfth of an inch in breadth when folded; and appear at first view, in this state, any thing but what they really are. They have indeed been often mistaken for a mere caudiform appendage to the other wings, from under which they emerge. When folded, and they fold themselves longitudinally like a fan, their very delicate texture is protected by the following simple contrivance. In each wing the two exterior longitudinal nervures, with their intervening membrane, are comparatively strong and thick; and these form the lateral walls of the wings when folded.

In each wing also there are two other nervures not far from the former, and circumstanced like them with respect

to strength; which, when the wings are folded, close together so as to form a horizontal covering, or roof, of sufficient strength to protect the subjacent membrane from ordinary accidents. As the narrow case formed by the wings thus folded extends beyond the extremity of the abdomen, and might easily slip off so convex and smooth a surface, such an accident is guarded against by the contrivance already described, namely, an apparatus of hairs or bristles placed on either side of the upper surface of the last segment but one.

*The digestive organs.** It is mentioned in the 48th Letter of WHITE's Natural History of Selborne, on the authority of Anatomists who have examined the intestines of the mole-cricket, that "from the number of its stomachs or maws, there seems to be good reason to suppose that it ruminates, or chews the cud like many quadrupeds." A cursory view of these parts however is enough to show, that such an opinion could only have been deduced from some very general points of resemblance, and the probability of its truth is entirely destroyed upon an examination of their internal structure.

In fact, the digestive organs of this insect resemble more closely those of a granivorus bird than of any other animal, as will appear from the following description. The esophagus, which on its upper side is blended with, and forms a continuation of the inner surface of the upper lip, commences on the lower surface in a loose corrugated tongue, as it were, which is attached at its base to the inner surface of the lower lip; from hence it is continued along the under part of the head and neck, and between the bony laminæ of the sternum,

* Vide fig. 6.

in the form of a distensible and longitudinally folded tube of a reddish brown colour; it then passes on among the muscles of the two hind pair of legs, and at length terminates in a very large crop of an oval form. In the vicinity of the mouth it is surrounded by muscles which arise from its outer coat, and are inserted at nearly right angles into the adjacent parts; these muscles of course serving to open and distend it.

In the crop itself two sets of muscular fibres are very easily discernible, some running in the direction of its length, others surrounding it in the opposite direction; and it is lined by a very thin membrane having a cuticular character.

The tube which passes from the crop towards the intestines commences so near the termination of the esophagus, that externally it appears to be a continuation of the latter; it is very thick and strong in comparison with its diameter, and consists of a coat of muscular fibres disposed circularly, lined by a membrane which has evidently a glandular character. This tube terminates at a short distance from its commencement in a small organ, scarcely larger than a hemp-seed, which may very properly be called a gizzard; though more complicated in its structure, and more effectual for the intended purpose than the gizzard of any bird.

The form of the gizzard is nearly spherical, and it consists of a thick external muscular coat, which is lined by a glandular membrane of very singular construction; the inner surface being divided longitudinally into six equal parts, separated from each other by two horny ridges of a dark brown colour; each division is furnished with three series of serrated teeth, of the consistence of tortoise-shell, and nearly

of the same colour, running from the top to the bottom; of which those of the middle series are twice as broad and more complicated in form than those of the lateral series. As there are fifteen teeth in each of the three series of the six divisions, the gizzard contains in the whole 270 teeth.* In separating the muscular coat of the gizzard from that which lines it, which may be easily done by maceration, the exterior surface of the glandular coat in which the teeth are inserted is exposed to view. The appearance of this surface is very singular, and may be compared to a piece of fine lace-work, of which the meshes represent the intervals of the inserted teeth, the parts of the membrane in which the roots of the teeth are inserted resembling the lace-work itself.

Four of the divisions above described are elongated so as to terminate in a tapering membranous appendage, consisting of a natural fold, which serves to convey onwards any fluid particles that may have been pressed out by the action of the gizzard; and these four appendages so collapse together as to form a point, as it were, which lies immediately in contact with the commencement of the common intestines. This apparatus is only discoverable by dissection; for it is contained in a large membranous cavity of the shape of a horse-shoe, the base of which passes across the lower extremity of the gizzard, while the sides form two enormous cæca, which ascend obliquely outwards on each side of the gizzard.

As the muscular compression of the gizzard must necessarily have a tendency to force a part of any expressed fluid back into the esophagus, we may expect this organ to be so constructed as to prevent such an effect; and it is pro-

* Vide fig. 6, 7, 8.

bably for this purpose, that its upper part is furnished with several projecting papillæ, each terminating in a small horny particle; which, like the sesamoid particles in the semilunar valves of the human aorta, may serve to complete the valvular action of the papillæ to which they are attached.

The cæca which have been above described, are traversed longitudinally by several very broad duplicatures of their internal membrane; and judging from their usual contents, these appendages of the intestine are destined to receive and to perfect the digestion of those particles of food from which the gizzard has pressed out the liquid contents; and while, by means of the membranous folds already described, the expressed fluid is conveyed immediately into the mouth of the intestinal canal that passes from the general cæcal cavity, the cæca themselves receive the solid compressed particles which are forced out laterally at the extremities of those two divisions of the gizzard, which, having no membranous fold attached to them, leaves thus a vacant interval for the passage of the undigested mass. That this opinion is correct may be presumed, not only from the very mechanism of the parts, but from the state of the contents of the cæca, which are of a less crude character than the contents of the crop, and of a more crude character than the contents of the portion of intestine immediately beyond them. A strong confirmation of the foregoing opinion is obtained from a comparison of this part of the anatomy of the mole-cricket, with that of the corresponding part in the ostrich; the stomach of which bird, acting like a gizzard by means of numerous pebbles which it takes into that organ, is aided by two enormous cæca, which, though they are not immediately in contact

with the stomach, are not far removed from it; and like the stomach, contain numerous pebbles, which are both smaller and smoother than those of the stomach itself, as being only destined to act on food already partially digested. The analogy on which I have just insisted, is strengthened by the fact, that there are very large duplicatures of the internal coat of the cæca of the ostrich, as in the corresponding parts of the mole-cricket. I either therefore misunderstand, or cannot agree with M. MARCEL DE SERRES, the author of a very interesting paper on the Intestinal Canal of Insects, published in the 76th vol. of the Journal de Physique; who seems to attribute to the æca above described, the office of an hepatic organ, and calls them "*Vaisseaux hépatiques superieures*," in contradistinction to another organ situated lower down in the intestines, and acknowledged by all to be of an hepatic character.

From the common base of the two cæca a very narrow but powerfully muscular tube, which might with much propriety be called the jejunum, passes onwards for a very short space, and terminates in a large intestine; this intestine, which is eight or ten times the diameter of the jejunum, contracts very gradually as it proceeds, till, near the extremity of the rectum it swells out very considerably. This large intestine is slightly convoluted in its course, and is usually more or less distended with a black pasty matter resembling soft clay. Among the contents of the upper part of this large intestine were almost invariably found from ten to twenty worms, of a white colour, and of a shape resembling the lumbricus teres of the human intestines, but thicker in proportion to their length, and narrowing more suddenly

towards their caudal extremity. In all of these worms the common intestines were distinctly visible through the integuments; and in many of them were distinctly visible also from ten to fifteen ova.*

On opening and removing the contents of the upper portion of the great intestine, four rows of minute bodies of a glandular character,† and of nearly a black colour, are brought into view;‡ two of which rows originate from the very commencement of the great intestine, and pass downwards through more than half its course: exteriorly to these two rows are two others, one on each side, which are parallel to the preceding, but originate at some distance from the commencement of the intestine. Immediately below the termination of this glandular apparatus is a small opening, very readily distinguishable on the inner surface of the intestine; which is the orifice of a cylindrical tube of a white colour, and of about the size of a horse hair. This tube, after having been traced a short distance in a direction towards the gizzard, is lost in a mass or brush of still smaller tubes of an exceedingly bright yellow colour; these tubes, which amount probably to 150 or 200,§ are partially coiled round the contiguous viscera so as not to be very easily disentangled. A

* Vide fig. 9.

† The only doubt which I entertain as to the glandular character of these bodies, arises from a reliance on the authority of CUVIER, who says, that the glands of insects are in every instance nothing more than parcels of free tubes floating in the interior of the body, and held together by the tracheæ." Journ. de Phys. Tom. 49. p. 344.

‡ Vide fig. 9 *a*.

§ CUVIER states in the Journal de Physique, Tom. xlix, p. 346, that the number of these tubes in the gryllotalpa amounts to many hundred: but I feel certain that he greatly overrates the number.

similar organ is represented in Sir EVERARD HOME's Comparative Anatomy, vol. 1. pl. 84, as belonging to the Cape grasshopper; it was originally considered by Mr. HUNTER, and is considered generally at present, as answering to the liver of the higher classes of animals.

Each of these tubes springs out of a common cavity in which the white tube from the intestine terminates; but at their free extremity they are all impervious. Each tube appears partially filled with a granular pulpy substance which is almost universally of a bright yellow colour; though sometimes a particle is visible here and there of a clear light green colour, and I have seen similar green particles in the duct leading from the intestines.

The following peculiarity is observable in the individual structure of these tubes: their diameter for about one-third of their course from the closed extremity is very small, and they are colourless, and apparently empty; after which they suddenly undergo a considerable enlargement, become yellow, and are partially filled with the contents above described.

Maceration in water destroys the yellow colour in the course of a few minutes; from whence it may be inferred, that after death the colouring matter transudes through the tubes containing it—a circumstance observable also with respect to the biliary vessels of the higher orders of animals; but it seems certain that no such transudation takes place during the life of the animal; for, upon examination of the insect soon after death, I have never found the adjacent parts coloured, as they would have been by the escape of the contents of the tubes.

The portion of the intestine below the orifice of the hepatic duct, as it may be called, appears to be externally traversed in a longitudinal direction by several rows of small convex eminences resembling beads; these are the outer surfaces of so many corresponding internal sinuses, which are probably formed as the similar sinuses in the large intestines of man, and many other animals, by a pecularity in the disposition of the fibres of the muscular coat.

Near the termination of the intestine are two orifices, one on each side, communicating each with a duct which soon swells out into a vesicular bag; these bags may probably be glands that secrete the fetid matter which the insect ejects from the anus when irritated. In one instance I found, on the site of the orifices above-mentioned, two small bodies about the size of a pin's head, of a dark colour, and to the naked eye of a spherical form; my surprize was considerable when upon observing them with a magnifying lens, I perceived that they exactly resembled a crystallized rosette of brown pearl-spar. Upon being removed and submitted to the requisite experiments, they proved to be of considerable hardness, sparry in their structure, and insoluble either in boiling water or alcohol; but they were dissolved with rapid efferverence in diluted muriatic acid. These calculous concretions were probably the result of diseased action in the vesicular glands round the orifices of the excretory ducts of which they had been deposited.

The blood. Upon wounding the animal in almost any part of the body, even in cutting off a portion of the caudal antenna, there oozes out a very clear thin fluid of a bright honey-yellow colour; having sensibly alkaline properties,

and coagulating either by heat or by the addition of alcohol. A quantity of this fluid, weighing 1.85 grains, being evaporated under an exhausted receiver, in which was placed dry muriate of lime, left a solid residuum of a bright golden yellow colour, which weighed 0.25 grains; this residuum was brittle, and had the general properties of solid albumen. The foregoing characters render it highly probably that the yellow fluid distributed through the body of the insect, resembles in its nature the serum of common blood, and there can be no doubt, arguing physiologically, that this yellow fluid is the blood or nutrient juice of the animal. I wish I could as satisfactorily show the means employed by nature to distribute this fluid through the system of this and other animals of the same class; for, though I cannot hope to discover what more experienced and skilful anatomists have sought in vain, a heart, namely, and a system of circulating vessels; yet I cannot subscribe to their opinion, that the blood transudes through the the coats of the intestines, where of course it must be primarily formed, and thence passes, as through the pores of a sponge to every part of the body. Both CUVIER and M. MARCEL DE SERRES completed a very elaborate set of experiments for the purpose of ascertaining whether the dorsal vessel of insects sends out any lateral branches which might serve the purpose of a circulating system, or whether any other distinct circulating system exists; but they have entirely failed in their endeavours; and I feel assured, that where such men have failed, others will not succeed; and yet their consequent supposition that the blood is diffused through the general substance of the body, appears to me very highly improbable. It accords not with

the general character of those means by which nature usually produces its effects; there is too little of art and contrivance, if I may use such terms, on such an occasion, in the mode supposed to be employed. Even in the formation of mineral crystals, which are unorganized bodies, the attraction by which the component particle are aggregated is regulated by laws, the most systematically framed and observed: and whoever has viewed with any attention that wonderful monument of human industry and sagacity, the Anatomical Museum of JOHN HUNTER, and has there seen the proofs of a sanguineous circulation in animals of an order so low, that they can hardly be said to have any specific form or substance, will almost necessarily be disposed to expect a similar provision in a class of animals, whose general structure is so elaborately and beautifully organized as that of insects. But I shall again advert to this subject after having described the tracheal system or respiratory organs of the insect under consideration.

The organs of respiration. As it is very generally known that the atmospherical air, so necessary for the existence of all animated beings, is admitted into the bodies of insects by certain apertures called stigmata, and is then distributed through the system by means of tracheæ or air tubes, I shall not dwell longer on the description of those organs in the gryllotalpa than is necessary for the elucidation of its particular history.

Omitting the questionable existence of two stigmata in the upper lip, and of two others in the vicinity of the caudal antennæ, there are ten stigmata very distinctly visible on each side of the body.* Hence, therefore, it is necessary to

* Vide fig. 10.

correct, though probably it has ere this been corrected by himself, a statement made by CUVIER in his Règne Animale, Tom. iii. p. 126, that in the myriapoda there are twenty stigmata and upwards; but in all other insects eighteen at most. He also asserts in the same place, that insects respire by two principal tracheæ extending longitudinally, one on each side of the body, from which other tracheæ ramify. Now certainly in the gryllotalpa, and, as I have reason to believe in many other insects also, the longitudinal tracheæ bear so small a proportion in their capacity to the aggregate capacity of the other tracheæ, that in such instances they cannot be called principal tracheæ. My own opinion is, that these longitudinal tracheæ serve as connecting channels, by which the insect is enabled to direct the air to particular parts, for occasional purposes.

Though not immediately bearing on the present point, I beg leave here to state a fact which I have not seen elsewhere noticed, that in the two segments of the body which carry the middle and hind pair of the true legs, in the larvæ of coleopterous and lepidopterous insects, there are no stigmata, discernible at least either to the naked eye, or a common magnifying lens.

But, to return to the stigmata of the gryllotalpa, the first in order beginning from the head, is situated very near the lower part of the posterior ridge of the thorax. This stigma, not to object to the term in the present instance, is apparently connected with all the tracheæ both of the thorax and of the head itself. It differs remarkably in size and form from all the rest; for instead of being a mere dot or point, it is an elongated fissure, bounded by two horny lips. The second stigma, which somewhat resembles in form, though of much

less extent than the preceding, is situated immediately behind the root of the middle leg; the third, which is still less than the second, is situated immediately behind the root of the posterior leg; near the termination of the dorsal part of the third abdominal segment; the fourth, fifth, and onwards to the tenth inclusive, are situated near the terminations of the corresponding dorsal segments of the abdomen.

I would here notice by the way, a peculiar appearance very constantly observable on the ventral surfaces of most of the abdominal segments between the hind pair of legs and the caudal antennæ. At either extremity of those segments there is a short line, not unlike that made by the stroke of a pen, passing obliquely downwards and inwards: it does not seem easy to conjecture the use of these lines.

I may state from repeated observations, that the stigmata, taken generally, are not the terminations of single tubes; very frequently two and often more than two tracheæ originate from the same stigma; and very soon after the commencent, one or even two of these tracheæ subdivide into numerous branches, which follow as nearly as may be the direction of the original tubes.

The distribution of many of the tracheæ may be very satisfactorily demonstrated by drying one of the insects under an exhausted receiver, containing muriate of lime: for after having been thus dried, the tracheæ become perceptible to the naked eye through the sustance of the integuments. The foregoing method of drying anatomical preparations may be successfully employed on many occasions; it answers particularly in the case of the human eye, or the eye of any sufficiently large animal; for, in the act of exhaustion, the air contained

in the vitreous humor of the eye becoming expanded, preserves the spherical form of the organ until the whole of the moisture has been evaporated; and it is then sufficiently firm to support itself. I have traced most of the tracheæ to the parts on which they are respectively distributed; but as no adequate object, nor indeed any object of importance, would be gained by the description of a distribution which is not marked by any physiological peculiarity, I shall only insist on such points as appear to me to be either new, or hitherto not sufficiently elucidated.

The tracheæ of insects are generally described as tubes constructed of a spiral thread, the successive coils of which are closely in opposition with each other; such a structure is represented in SWAMMERDAM's plates, and I have no doubt from his acknowledged accuracy, that he represents what he observed. It has not however happened to me, with the exception of one equivocal instance, to perceive such a structure in the mole-cricket, the character of the tracheæ of which varies in different parts of the insect; for sometimes they resemble the pulmonary tracheæ of the higher classes of animals, in having an annulated structure; and sometimes they appear as tubes of a perfectly uniform substance like cuticle, or some very thin and unorganized membrane. It is generally understood, that the tracheæ of insects penetrate each organ and every part of the body: and certainly the case is such in the instance before us. Thus, in that brush of capillary yellow tubes supposed to constitute the hepatic system, the total number of which amounts to 150 or 200, there is reason to believe that each tube is accompanied by a distinct trachea coiled round it in a long spiral. Again; the

two medullary cords which connect the several ganglions of the nervous system, are in their natural state united together by means of the branches of a tracheal tube which runs between them; a similar tube being attached to the exterior edge of the cords; and the surface of what may be called the brain of this insect, is as beautifully characterized by the ramifications of the tracheæ which pervade it, as the surface of the pia mater of the human brain by the blood vessels which penetrate that membrane in every direction.

In meditating on the difficult problem of the sanguinous circulation of insects, it has forcibly occurred to me, that the tracheæ may possibly be the instruments of such a circulation; absorbing the blood or the chyle in the first instance from the internal surface of the alimentary canal, and thence conveying it to the various parts of the body; nor is this opinion, however improbable it may appear, entirely gratuitous. No difficulty, I apprehend, attaches to the supposition that such an an absorption may take place; seeing that innumerable minute ramifications of the tracheæ penetrate the intestinal canal in every part: nor does there seem any difficulty in admitting that the insect may, by the power of exhausting the air from individual tracheæ, draw on the absorbed fluid towards those two lateral tracheal tubes, which are apparently a general medium of communication between all the other tracheæ of the body. And, when once the blood has reached this supposed point of its course, it is manifest, that by whatever means the air itself is forwarded from the same point to the most distant parts of the body, by a modification of the same means, the blood may be forwarded to the same part; and the elegant proposition of CUVIER,

that "the blood being incapable of going in search of the air, the air goes in search of it," will still remain inviolate.

If it should be argued that the tracheæ are not found charged with blood after the death of the animal, it may be answered, that neither are the arteries in the higher orders of animals found charged with blood after their death. However, I have actually seen some of the ramifications of those tracheæ which are connected with the cæca distended with a fluid of the same colour as that found in those organs; and though I have only witnessed this fact in two instances; yet such a fact, even singly taken, must be allowed to be of considerable importance.

Of one thing I am certain, that, after careful observation, I have never found the abdominal viscera, I will not say bathed, as some authors of credit have expressed themselves, in the nutrient fluid which is supposed to have transuded through the coats of the intestines; but I have not even found them lubricated by a greater proportion of moisture than lubricates the intestines of the higher classes of animals.

There is another difficulty which occurs to the hypothesis of the transudation of the chyle through the coats of the intestines; for, if the blood be conveyed to the several parts by previous general diffusion through the interior of the body, and then by absortion into the substance of particular organs, as the hepatic tubes, the vesiculæ seminales and the ovaries; how does it happen that the bile, for instance, does not transude through the coats of the same vessels, the pores of which have admitted the blood from which it has been formed? It may be answered, that the alteration which the

blood undergoes in the several organs, changes its properties to such an extent, as to render it incapable of repassing through the pores which admitted it. I cannot of course presume to say that such is not the case; and I am aware that many entomologists will be surprised at, and perhaps disinclined to listen to the opinion here advanced with respect to a sanguineous circulation in insects; but I nevertheless hope that the opinion will not be rejected without some previous attention to it. With regard to the dorsal vessel of the gryllotalpa, which in this, as in other insects, has been supposed to stand in the place of an arterial heart, I have very few observations to offer. It does not agree in its form with the description commonly given of this mysterious organ; for though it diminishes in diameter as it approaches the head, this is by no means the case towards the other extremity of it. I have not yet completely succeeded in tracing this vessel to its anterior extremity; because as it approaches its termination in that direction, it becomes so delicate as to have hitherto broken under dissection before I arrived at the extremity of it. Towards the opposite extremity it gradually becomes larger from the centre of the body, and terminates apparently in a cul de sac about the last segment but two of the abdomen.

The muscles. In the gryllotalpa, as in insects in general, the muscles are exceedingly numerous, and usually very distinctly defined; but as their form and size in different parts of the body may, without difficulty, be conjectured from the form and size of the parts to which they are appropriate, I need not occupy the time of the Society by enumerating or particularly describing them. Those which move the fore

legs are remarkable for their size, and apparently fill nearly the whole of the interior of the thorax. Some muscles, as is the case with two belonging to each mandible, and with some of those that are situated within the thigh of the hind leg, have tendons attached to them of considerable extent and strength. I must not omit to mention several parallel muscular bands, which run in a longitudinal direction along the outer coat of the extremity of the great intestine, and are inserted into what may be called the sphincter of the rectum: these muscular bands may evidently assist, by their previous contraction and subsequent relaxation in discharging that fœtid matter, which as has been already said, the animal usually emits when irritated. For the discovery of these muscles I am indebted to Mr. WHESSELL, whose name I have before mentioned on a similar occasion.

*The nerves.** In removing the integuments throughout the whole length of the lower surface of the body, we discover a series of nine ganglions, of a pale cream colour, distributed at unequal intervals from the commencement of the esophagus to the termination of the rectum; a double medullary cord being continued from one ganglion to another throughout the whole series. The ganglions and their connecting cords lie so nearly in contact with the common integuments, that great care is requisite, lest, in removing these integuments, the nerves themselves should be removed, or at least injured. The first of these ganglions, reckoning from the anal extremity of the abdomen, is globular in its form; and is situated between the intestine and the sexual organs, the latter being placed immediately under the ventral integuments. This

* Vide fig. 11 and 12.

ganglion gives off several pairs of nerves, of which by far the largest pair may be traced into the caudal antennæ. The second, third, and fourth ganglions are smaller than the first, and are of an oval rather than a globular form: they each send out from two to four or five pairs of nerves. The fifth and sixth ganglions of which the former is the smallest, the latter the largest ganglion, of the whole series, are situated so closely together, that it not always easy to demonstrate the connecting medullary cords. The sixth ganglion, which from its size and the number of nerves radiating from it might be called the solar ganglion, is situated between the roots of the posterior legs. The seventh and eighth ganglions are situated respectively between the roots of the middle and the fore legs.

From the eighth ganglion, which lies under the furcular bone of the sternum, two parallel medullary cords pass on to the root of the mandibles, where they unite with the ninth and last ganglion, which is situated under and in contact with the commencement of the esophagus. This ganglion, which is hollow, as perhaps all the others may be, sends off nerves to the maxilla and adjacent parts: and it sends off besides, two large and important branches which ascending on each side of the esophagus unite with two corresponding branches that descend from the brain; which organ is situated immediately in contact with the commencement of the esophagus on its upper surface: so that the esophagus is placed between the ninth ganglion on its lower surface, and the brain on its upper surface, their connecting branches completing the nervous collar which surrounds it at this part.

The brain differs in colour from the ganglions, being of a pale brownish pink, instead of a cream colour, and in size it far exceeds the largest of the ganglions. It consists of two hemispheres, separated by a fissure, from each of which pass out four processes; the first of these processes unites as above described, with a process from the ninth ganglion, to form the nervous collar of the esophagus; the second passes to the root of the antenna; the third, which may be called the optic nerve, passes towards the inner surface of the cornea; and at its extremity swells out into a fringed coronet of an orange red colour; the fourth process, the extremity of which is also of an orange red colour, proceeds to the ocellus or stemma of the corresponding side.

The upper surface of the brain is covered by a mass of soft substance somewhat resembling loose fat.

*The sexual organs of the female.** These organs consist of two ovaries, which occupy a considerable portion of the upper part of the abdomen, and terminate by a narrow duct in a common cavity or uterus, which opens externally under the posterior edge of the last segment but one of the ventral surface of the abdomen. Behind the uterus is an oblong white body, which originating from a cul de sac, and then doubling on itself in the form of a slender tube, terminates in the uterus. The contents of this body resemble a thin white paste. The ovaries are irregularly pear-shaped, and consist of a transparent membrane irregularly convoluted, through which the ova, enveloped in a gelatinous medium, are easily distingushed. In the same ovary the ova are frequently of different sizes and colours; those which are the

* Vide fig. 13.

largest, and which I suppose to be impregnated, are of a brownish yellow colour; they resist a considerable degree of force before they burst, and the contents when pressed out melt as it were into a soft jelly, leaving a tough membrane which enveloped them. The smaller ova are of various sizes and of nearly a white colour, and of a much more slender and compressed form than those which I have supposed to be impregnated. This difference in the degree of maturation corresponds with a fact stated by RÖSEL, that the mole-cricket does not deposit all the eggs of the season at one time. In a few instances I found two or three ova which had entered the narrowest part of the duct and were very near the uterus; and from the appearance of these, which may fairly be supposed to be, if not impregnated, at least in a state fit for impregnation, I have ventured to derive the character of the impregnated ovum.

*The sexual organs of the male.** I had dissected several male gryllotalpæ before I was fortunate enough to meet with the sexual organs fully developed; and while I had as yet met with only one animal bearing the character of full developement, I was not certain whether I judged rightly of the natural state of those parts; or whether their uncommon degree of enlargement were not the effect of disease—the disproportion in size between the state in which they had hitherto occurred, and that to which I now allude is so enormous. However, subsequent dissections presenting the same phenomena, I have no scruple in considering them as indicating full developement.

The testicles of the male are situated similarly to the

* Vide fig. 14.

ovaries of the female, and are not very unlike in general appearance to the ovaries of young females; they differ however in being divided pretty deeply into several unequal lobes, the free extremities of which look towards each other. They send out each a very fine capillary tube or duct; which, descending towards the rectum, is in one part of its passage convoluted on itself so as to resemble the human epididymis partially unravelled.

The excretory duct above described terminates at the bottom of a thick pouch, which is situated between the rectum and the ventral integuments, and in form is not very unlike, though larger than the uterus, opening externally, as the uterus does, under the posterior margin of the last but one of the ventral segments of the abdomen.

The interior mechanism of this pouch is extremely curious; for in the upper part there is contained an apparatus somewhat in the shape of a coronet, of the colour and hardness of tortoise-shell: and at right angles to the centre of this there is fitted a similarly hard and horny substance, (in shape resembling a short flat club,) which descends towards the external opening of the pouch.

Behind the pouch are situated one on each side, two oblong white bodies, which are twisted into three spiral coils, and then terminate by an inflected tube at the upper and back part of the pouch. These bodies evidently answer to the vesiculæ seminales of insects in general: and resemble in their external character, and in their white pulpy contents, that oval body which is placed at the back of the uterus. There is also another pair of vesiculæ seminales, as is frequently the case in insects, situated exteriorly to the former;

more slender in form, also and much more convoluted, which apparently terminate near the points where the ducts of the testicles terminate. In the instances of full developement these bodies are enlarged to six times their usual size. Under the circumstances of full developement there is also found, though scarcely perceptible under imperfect developement, a large spherical mass, resembling a ball of eider down, situated immediately at the anterior edge of the pouch above described, and continued on from its substance.

The examination of the mole-cricket has added, as appears from the description of the parts, another exception in the case of the female as well as the male to the general statement, that in insects the sexual organs pass out by the anus. CUVIER mentions, as the only exceptions to this law, the Iuli and libellulæ.*

Casting of the skin. The following are the only observations I have had an opportunity of making as to this point of the history of the mole-cricket. In the process of moulting, the skin of the abdomen appears to split longitudinally down the middle of the upper part; and the skin of the thorax separates in a similar direction; but the skin of the head only separates partially in that direction, and then splits bebetween the stemmata, in a direction towards each of the antennæ; so that the line of separation somewhat resembles the lambdoïdal suture of the human skull.

The corneæ of the eyes are cast with the rest of the skin, as in the case of the snake; but they lose their transparency, and become of a greyish white colour,

Even the covering of the claws is cast.

* Règne Animale, Tom, iii. p. 137.

The newly exposed surface of the whole body is covered with the same kind of down as that which covered the preceding skin; except in the case of the long bristly hairs of the caudal antennæ, which apparently are produced afterwards. The colour of the body immediately after the casting of the skin is yellowish white, and it remains of that colour for a few hours: it afterwards gradually darkens.

The organ of sound. I have very little doubt that the peculiar sound which is charcteristic of this insect is produced by the wings; for I have observed in several individuals in their perfect state, that, when irritated, they will separate their upper wings by a brisk motion laterally from each other; and that upon their being suddenly brought back to their natural position, a sound is at the same moment produced, resembling that which I have heard the insect spontaneously produce during the season of summer; but I could not fix the power of producing this sound to either sex exclusively.

There is a peculiar organ, forming a part of the common integuments of the abdomen, and situated between the fourth and fifth stigma on each side; the anterior portion of which consists of a tense membrane, like fine parchment, of a semilunar form; this organ from its individual character might be supposed to contribute towards the production of the sound, but it is found in the female as well as in the male; and its supposed use is not justified by the presence of any internal mechanism.

In two or three instances I have perceived the internal and upper surface of the second abdominal segment, answering to what is generally called the third thoracic segment, furnished with two oblong concave laminæ, terminating in free

rounded edges, which are probably elastic; but I feel by no means certain that these are exclusively characteristic of the male, though I certainly found them most distinctly developed in a male individual.

But my acquaintance with the interesting insect, the history of which has formed the subject of this paper, did not commence till towards the close of that period of the summer during which the animal is heard to produce its peculiar sound: and I propose therefore to resume the investigation of this point at a future opportunity.

Oxford, Nov. 13, 1824.

Dimensions of a full grown mole-cricket.

	Inches.
Length of the body from the extremity of the lip to the extremity of the vent	2.0
Length of the head	0.165
——— thoracic division	0.5
——— abdominal division	1.33
Breadth of the thorax	0.5
——— abdomen	0.5
Length of the antennæ of the head	0.825
——— caudal antennæ	0.666
Length of the whole alimentary canal	2.0
——— esophagus	0.5
Length from the crop to the great intestine	0.5
Length of the great intestine	1.0

EXPLANATION OF PLATE XV.

Fig. 1. Skeleton of the head, viewed from the under side.

Fig. 2. A side view of the animal in its common attitude.

Fig. 3. Skeleton of the thorax.

Fig. 4. Sternum, &c. with the upper part of the thorax adhering.

Fig. 5. Exterior surface of the left fore leg.

Fig. 5^a. Parasitic insect infesting the roots of the wings; of its natural size, and also enlarged.

Fig. 6. Esophagus, crop, gizzard, cæca, great intestines, hepatic organ, and anal glands.

Fig. 7. Interior view of gizzard.

Fig. 8. Ditto of a portion of ditto.

Fig. 9. Intestinal worm of the mole-cricket; natural size, and enlarged.

Fig. 9^a. Upper part of great intestine, with four rows of glands, and the orifice of the hepatic duct.

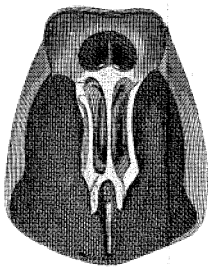
Fig. 10. The stigmata of the left side; with the organ (situated between the fourth and fifth stigmata) described in page 224.

Fig. 11. The nine ganglions.

Fig. 12. The brain, surrounding the esophagus.

Fig. 13. The female sexual organs.

Fig. 14. The male ditto.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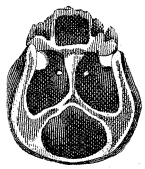
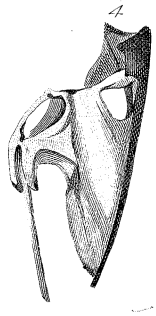


Fig. 1.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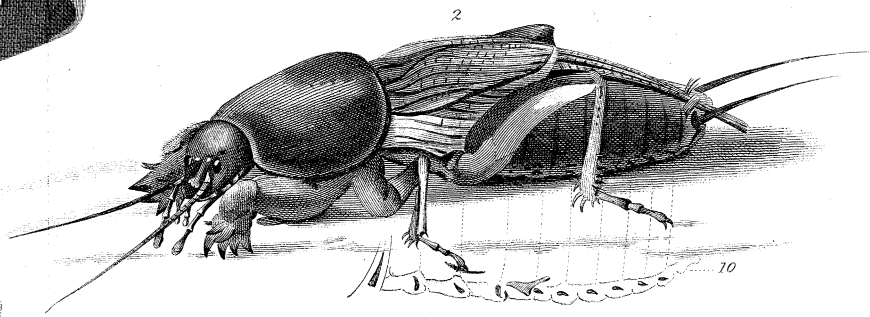
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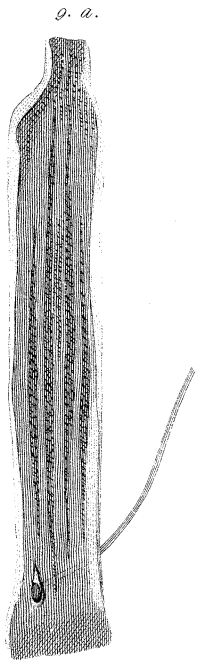
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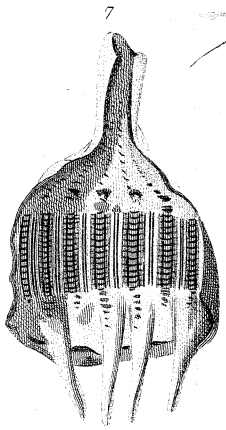
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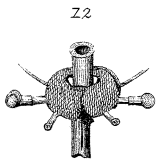
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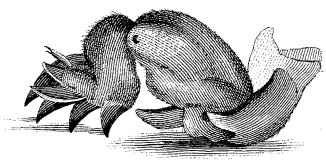
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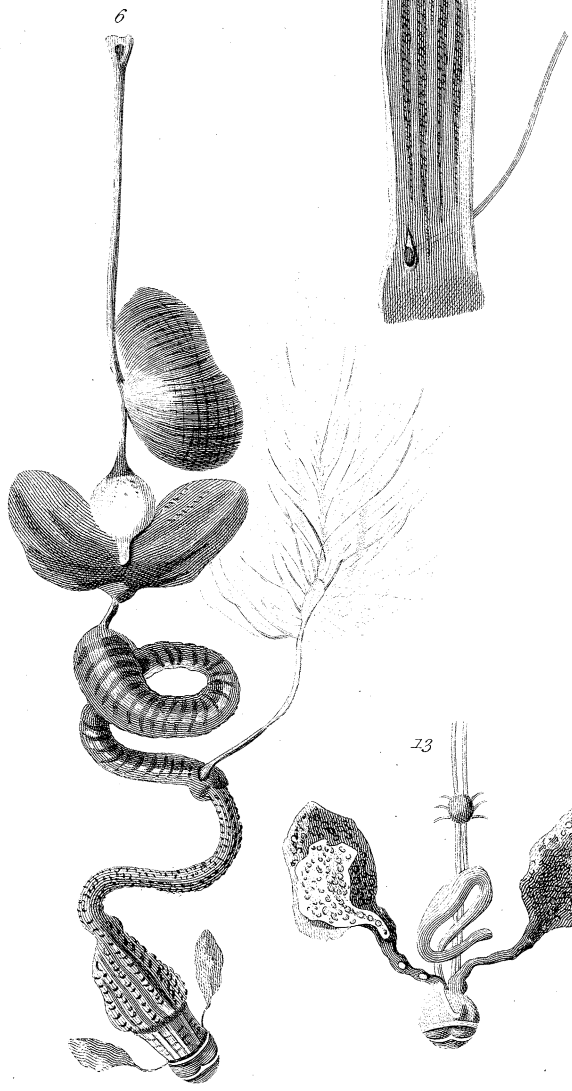
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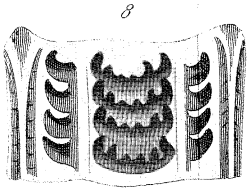
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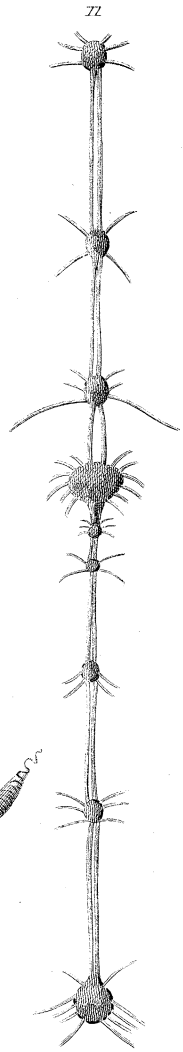
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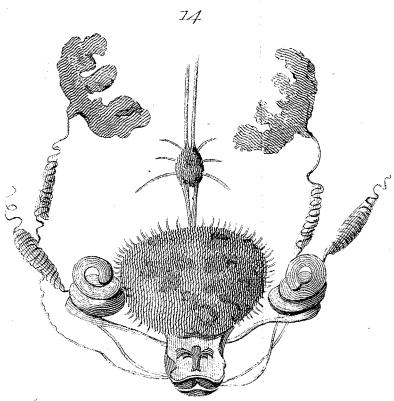
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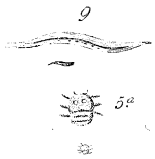
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